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Executive Development

Methicillin-Resistant Staphylococcus Aureus and Tucson Fire Department

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Appendices Not Included. Please visit the Learning Resource Center on the Web at http://www.lrc.dhs.gov/ to learn how to obtain this report in its entirety through Interlibrary Loan.

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Abstract

The problem is that Methicillin-Resistant Staphylococcus Aureus (MRSA) poses a significant health and occupational risk to members of the Tucson Fire Department. The purpose was to identify the processes and protocols to help mitigate the risks for MRSA to Tucson Fire Department personnel. Descriptive research methodology was used to answer the following research questions: A) What are the current standards for mitigating MRSA infections advocated by the Centers of Disease Control? B) What are healthcare institutions doing to mitigate the risk of MRSA infections? C) What are fire departments within the continental United States doing to mitigate the risk of MRSA infections? D) What is the Tucson Fire Department doing to mitigate the risk of MRSA infections? A literature search, internal and external questionnaires revealed that MRSA is a problem for the fire service in general as well as the Tucson Fire Department. Recommendations include increasing education and awareness, engineering protective measures into the workplace and enforcing standard operating procedures and guidelines where appropriate in an effort to mitigate this growing problem.

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Introduction

Infectious disease prevention is a constant battle for healthcare professionals. Of the infectious diseases, the ones that are resistant to current antibiotic treatment modalities are some of the most dangerous (W. Peate, personal communication, January 7, 2007). In the December, 2007 Journal of American Medical Association, it was stated that Methicillin Resistant Staphylococcus Aureus (MRSA) would cause more deaths in 2008 than Acquired Immune Deficiency Syndrome (AIDS) (Klevens, 2007).

The United States Fire Service responds to nearly three million calls for service annually (USFA, 2007). Of these, fifty-five percent are Emergency Medical Service (EMS) orientated (USFA, 2007). In 2006, the City of Tucson Fire Department responded to nearly 70,000 calls for service, with just over 60,000 being EMS related (TFD, 2007, p.17). It is during these EMS related calls that firefighters are potentially exposed, knowingly, or not, to several types of communicable and infectious diseases.

Methicillin Resistant Staphylococcus Aureus (MRSA) is one of the emerging infectious diseases that has great potential for causing multiple issues for not only the fire service, but for patients and family. Many fire service providers, including the Tucson Fire Department may not be aware of the potential for MRSA infection, and departments may not be employing effective mitigation therapies.

The problem statement is that Methicillin-Resistant Staphylococcus Aureus poses a significant health and occupational risk to members of the Tucson Fire Department. The purpose

was to identify the processes and protocols to help mitigate the risks for methicillin-resistant staphylococcus aureus (MRSA) to Tucson Fire Department personnel.

Descriptive research methodology was used to study the present situation and formulate a course for corrective action. The research questions are (a) What are the current standards for mitigating MRSA infections advocated by the Centers of Disease Control, (b) What are healthcare institutions doing to mitigate the risk of MRSA infections, (c) What are fire departments within the continental United States doing to mitigate the risk of MRSA infections, and (d) What is the Tucson Fire Department doing to mitigate the risk of MRSA infections?

Background and Significance

The City of Tucson Fire Department began in the early 1880's as an all-volunteer service and today protects some 550, 000 residents in an area of 250 square miles from 21 fire stations with a daily firefighting force of 186 (TFD, 2007 p.17). The Tucson Fire Department responds to over 60,000 EMS calls each year (TFD, 2007 p.17).

In 2006, a member of the Tucson Fire Department (TFD) awoke at the station with what looked like a spider bite on his foot. Within weeks, after the problem worsened and did not clear with normal antibiotic therapy, the wound was cultured and found to be MRSA, requiring multiple therapies to bring it under control. Soon after, a second member at the same station, who uses the same dorm room, had what appeared to be a spider bite. Although this infection was not MRSA-based, it caused a significant level of concern to the members of the station, resulting in an investigation launched cooperatively through the department and the department's industrial physician provider, WellAmerica, Inc. Shortly thereafter it was learned that another member whose MRSA infection was not covered by industrial insurance had unknowingly

passed the infection to his infant daughter. This caused a heightened level of concern across the department and led to a joint meeting between union, management and the industrial physician to assess the scope of the problem. It was at this meeting that the potential for this infection to the members of TFD was discussed. Since then, several members have been diagnosed with MRSA, resulting in multiple surgeries, hospitalizations, many hours of lost productivity as well as the emotional consequences of such an illness. This problem has not affected only the Tucson Fire Department at the personal level, but this lost time directly affects the ability for the department to carry out its mission statement.

On Nov. 18, the Dallas Morning News ran an article titled "*Widow seeks answers after TX firefighter dies of* MRSA." In May 2007, a 33 year old Texas Firefighter noticed a pain in his lower back. He saw multiple doctors over a 10-day period and was put on painkillers as doctors could not figure out what was wrong with him. On day 11, he was rushed to a hospital in respiratory distress and kidney failure. After more testing over a two-day period, he was diagnosed with a severe infection of unknown typing. Later that day, he died of a multiple organ failure sepsis caused by MRSA. An antibiotic-resistant staph infection, methicillin-resistant staphylococcus aureus killed a strong, healthy firefighter in less than two weeks.

In 2007 alone, TFD had three confirmed diagnosis of MRSA, with many others treated empirically for MRSA with a total cost for only office visits and telephone consults of $1143.79. This does not include Emergency Department visits, hospitalizations, surgeries, or specialist costs which would drive this number much higher. There were approximately 37 cases of personnel being exposed to respiratory MRSA alone during 2004- 2007. Table 1 summarizes numbers of TFD personnel treated for MRSA 2004-2007.

Table 1

TFD MRSA Cases 2004-2007

	2004	2005	2006	2007
Cellulitis	2	6	3	6
Respiratory MRSA exposures	7	2	2	26

Source: WellAmerica, Inc.

This problem is important to the author as he is the Deputy Chief of Safety, Health and Wellness for the Tucson Fire Department. The author has been involved in this issue for over two years and considers it a mandate that everything should be done to mitigate this potential deadly infection and in the process many other common illnesses may also be prevented, resulting in a decrease in cost and an increase in productivity.

Methicillin-resistant staphylococcus aureus (MRSA) has undoubtedly caused numerous infections that were not diagnosed as MRSA. The problem of MRSA is not going away, as these types of "super-bugs" are able to alter their own genetic material to build resistance to the very antibiotics used to control them.

This paper will assist the Tucson Fire Department in obtaining information through descriptive means to determine whether more can be done to protect Tucson Firefighters from MRSA. It also serves to assist in the United States Fire Administrations five operational objectives by specifically addressing the fifth, which states "To respond appropriately in a timely manner to emerging issues" (USFA, 2005 p.3). A major goal of the *Executive Development* course is to focus the attention of Executive Fire Officers (EFOs) as leaders on transforming fire and emergency services to stay abreast of new issues that can pose a threat to firefighters.

Literature Review

The purpose of this literature review is to set the foundation of this study. It is valuable because it illustrates the findings others have made on this same research topic. The author looked at fire service, hospital, and long-term health care literature to develop basic understanding on the history and topic of MRSA. Articles relating to communicable and infectious diseases were also studied. The information in this research project came from current research and numerous articles on communicable diseases to include MRSA. The research was done through sources including the Internet, journals, and the library at the National Fire Academy. When researching from the Internet, the Google search engine was used, using the keywords: MRSA, communicable diseases, firefighter, and EMS.

MRSA and Its Origins

Methicillin-Resistant Staphylococcus Aureus is a bacterial infection that may at times be called merely "staph." MRSA has been around for many years. It first appeared in hospitals as a staph infection that was resistant to Methicillin, which was commonly used. MRSA was one of the first strains of bacteria to "outwit" all but the most powerful drugs (Mayo, 2007). Methicillin began to be used in 1959 to treat infections caused by *Staphylococcus aureus* that was penicillin-resistant. As early as 1961 there was evidence from the United Kingdom of *S. aureus* isolates (to separate a pure strain from a mixed bacterial or fungal culture) that had already acquired resistance to methicillin (methicillin-resistant *S. aureus*, MRSA) (Enright, et al, 2002). Hitti found nearly a seven times increase in community acquired Methicillin Resistant Staphylococcus Aureus (CA-MRSA) infections during the years studied. CA-MRSA is a strain of MRSA that has spread to the community and is therefore passed amongst members of the general society

who have not been hospitalized within one year (CDC, 2008). “An increase from 24 cases per 100,000 people in 2000 to 164 cases per 100,000 people in 2005 was documented” (Hitti, 2007). MRSA is becoming increasingly prevalent in society, the same society firefighters are sworn to protect and care for.

Approximately one-third of the population is colonized with MRSA but shows no symptoms of being ill. Colonization means that the infection (MRSA) typically resides on the skin or in the noses of normal health persons, such as firefighters, however, their immune systems keep it “in-check” and symptoms do not occur. They can pass the bacteria onto others, such as patients, and family members. The young, the old and the infirmed are at greatest risk (CDC, 2005, February 3).

If MRSA enters the body through a wound, it usually results in nothing more than a minor skin irritation, however, severe disease, including necrotizing pneumonia (a rare bacterial infection that can destroy the membranes of the lung), necrotizing fasciitis (a rare bacterial infection that can destroy skin and the soft tissue beneath it, including fat and the fascia that surrounds muscle and bone), severe osteomyelitis (a bone infection usually caused by bacteria that can be acute and chronic) and a sepsis syndrome (an often life-threatening illness characterized by massive infection resulting in multiple organ failure) with increased mortality have also been described in children and adults (Seigel, et al, 2006). In the 1990’s, a strain of MRSA began showing up within the community at large and is now responsible for many skin, systemic and pneumonia-type infections. MRSA can sometimes be called a ‘superbug’. This strain of MRSA is called Community Acquired MRSA or CA-MRSA.

CA-MRSA often presents as a small red bump on the skin that resembles a bug or spider bite. Without immediate treatment, these bumps can soon turn into boils and large abscesses that cause extreme pain. The infection however continues to find its way deeper into the patient's tissue, often reaching bones, joints and possibly the heart or lungs. If these infections progress into organs, they can eventually lead to death (CDC, 2005, February 3).

When Penicillin was first introduced in the 1940's by Howard Florey and Ernst Chain, it began to be prescribed continually. Even though bacterium replicate naturally, quite often, in the early years of antibiotic therapy, penicillin and other antibiotics were prescribed for viral type infections such as the common cold and influenza (Mayo, 2007). Antibiotics can also be found in water supplies, food such as poultry, beef and pork, as well as other food sources. This practice allowed bacterium to mutate faster and change their genetic makeup. This fast paced mutation occurs far ahead of the ability for science to create new antibiotic therapies, thus the "resistant" portion of the MRSA name. Antibiotic drugs do not eradicate all bacteria, and *even* correct, regular use of antibiotics may contribute to the germ's mutation. This is why it was so prevalent in the hospital environment (DeNoon, 2008).

The Introduction of MRSA into the Community

Although there is much literature attempting to explain the initial cases of MRSA in the community (CA-MRSA), there is no one universally accepted definition of what exactly constitutes CA-MRSA and its origin is still under study. MRSA was initially thought to have come from hospital or long- term health care settings, but recent studies convey its apparent independent emergence. Genetically, both HA-MRSA and CA-MRSA are harbored within the Staphylococcus Cassette Cartridge (SCC), which carries the mecA gene – a resistance gene that

causes altered binding of β-lactams (class of antibiotics) to penicillin binding protein 2a (Kowalski, et al, 2005). Per Dr. Kelly Reynolds, HA and CA MRSA SCCmecs are of different sizes, indicating different origin. In addition, almost all CA-MRSA isolates in the United States contain genes encoding the Panton-Valentine leukocidin (PVL), which is a cytotoxin (cell toxin) that causes leukocyte destruction and tissue necrosis such as cutaneous abscesses and cellulitis (K. Reynolds, personal communication February7, 2007). This is what gives the typical appearance of the boil-like infection that oozes exudates (materials such as fluid, cell, or cellular debris that has escaped from blood vessels and entered into tissue). Because there are these genetic differences, HA-MRSA and CA-MRSA present differently, with the CA-MRSA most commonly appearing as the typical skin infection, usually in healthy people like firefighters. Dr. Elizabeth Bancroft, MD, a medical epidemiologist with the Los Angeles County Department of Health Services gave testimony to the House Oversight and Government Reform Committee on November 7, 2007 and stated "it appears that the two main types of MRSA, hospital acquired and community acquired arose separately and that the community strain is not simply a rogue hospital strain."

The main transmission mode of CA-MRSA is the hands (W.Peate, personal communication, February 24, 2007). This is obviously a concern for the firefighting community, as a great deal of fire departments now engage in the provision of Emergency Medical Services (EMS). By being in these environments, firefighters are constantly using their hands to perform patient care. Other factors contributing to transmission include skin-to-skin contact, crowded conditions and poor hygiene (CDC, 2005, February 3). Lejune and Berkowitz (2000) also state that MRSA can live on surfaces for an "undetermined" length of time. Knowing these facts about

MRSA spread, the issue of the firefighters bringing it via their hands, uniforms and/or turnout clothing into their living environment is a real possibility. As mentioned earlier, this is exactly what happened to a Tucson firefighter in 2006 when he spread the infection to his toddler daughter.

Firefighter Exposure to MRSA

A 2007 report from the Association for Professionals in Infection Control and Epidemiology estimates that 1.2 million hospital patients are infected with MRSA each year in the United States. They also estimate another 423,000 are colonized with it (Mayo, 2007). It is also infecting much younger people. The Journal of the American Medical Association studied the people in Minnesota and found that the average age of people with HA-MRSA was 68, while the average age of a person with CA-MRSA was 23 (CDC, Perlman, 2007).

As these numbers rise, it is inevitable the firefighter will engage multiple situations where MRSA is a threat. Nursing homes or other long-term care type facilities are a large risk to the firefighter as MRSA is extremely prevalent there as well. In fact according to the Mayo Clinic article, MRSA is much more commonplace there than in the hospital environment (Mayo, 2007).

As Medicare and other insurance carriers pay for less, hospital and nursing home stays are shorter wherever possible. Patients are quite often sent home with instructions on how to care for themselves or have others care for them. This typically includes wound care, invasive devices such as catheters for feeding or urine evacuation, drug administration and dialysis cleansing. These openings in the body are ripe for bacterial proliferation.

As stated before, MRSA can be especially dangerous in young people and firefighters often respond to calls for help in this area of the population. What can start out as a simple cut or

scrape, can become a life-threatening event as a child's immune system has not yet developed fully nor built up antibodies to common germs. This can result in a quickly progressing systemic infection. There is also an increased risk in this population for more severe pneumonias for the same reasons as listed above. It is obviously critical that firefighters neither pass this type of infection from patient to patient or to their own family. A Tucson firefighter in 2006 noticed a rash on his neck. This rash would not go away and his primary care physician treated him for a common infection. The original antibiotic did not work, and he subsequently was diagnosed with MRSA. A second antibiotic was effective, but soon thereafter, his 14-month-old daughter was diagnosed with MRSA of the skin. It can be reasonably assumed that she contracted it from her firefighter father (W. Peate, personal communication, February 24, 2007). She too was treated effectively, but also not before two types of antibiotics were used.

Firefighters are often called to assist with sporting injuries. CA-MRSA has been found to be aggressive in the contact sports, as there is ample opportunity due to cuts, scrapes and other injuries. There have been both professional and college level athletes who have lost careers, limbs, and lives due to CA-MRSA. Lycoming College football player Ricky Lannetti died from CA-MRSA. Lannetti was admitted to Williamsport Hospital with a blood infection after preparing for a game but later lost his life after multiple organ failure from MRSA (MRSA Resources, 2007).

In "Sick Fire Stations" (*Fire Chief* blog July 20, 2007), editor Janet Wilmoth describes a California scenario in which nine firefighters were afflicted with some type of infection and at least two of these tested positive for MRSA. The firefighter environment is not unlike athletes, where common shower, bathroom and facility use, and the sharing of towels, razors, combs, etc

may contribute to the spread of CA-MRSA. Although some of the shared personal hygiene areas such as sinks, showers, and toilets are most likely cleaned on a daily basis, the cleaning methods may not be effective against MRSA. Another area of concern in society is the workout areas in local gyms. MRSA has been found on equipment such as cardio-exercise, weight benches, handles and common showering areas (DeNoon, 2008). If these types of inanimate objects can be vehicles for transmission, it then can be reasoned that firefighting equipment such as turnouts, EMS equipment bags, EKG monitors, etc can also.

In June, *Journal Watch Emergency Medicine* published "MRSA in the Ambulance," summarizing a study from *Prehospital Emergency Care,* (April/June; 11(2): 241-4, "*Can (MRSA) be found in an ambulance fleet?"* According to the study, 48 percent of ambulances tested positive for MRSA. One urban EMS service was tested at multiple sites within the ambulance. Twenty-one ambulances were tested, with ten of those demonstrating a positive result. Positive test results were found in a number of areas in the ambulance, including the steering wheel, stretcher, patient compartment and Yankauer tip suction catheter.

Rarely are firefighters called because someone is having a good day. Certain calls can elicit an adrenaline-type response. On these types of calls, focus and high degree of suspicion can potentially go by the wayside. This can cause a breakdown in putting those efforts or practices into place that can reduce exposure potential.

Firefighters also are prone to entering atmospheres where crowded or unsanitary conditions are common. Poor hygiene and crowded living conditions are risk factors (Hitti, 2007). These areas of the community are at an increased risk of housing the CA-MRSA organism. Persons in direct contact with other healthcare professionals are also at a higher risk

because these persons work directly in the areas where MRSA is known to exist. Firefighters, paramedics and other first responder personnel come into contact with these workers on a regular basis.

Tucson Fire Department Study

MRSA can live on surfaces for extended periods of time, the exact length of which has not been specifically identified. Its ability to live on surfaces such as gurneys, bedding, and bar soap can lead to "indirect transmission" of MRSA to emergency services personnel (Lejuene & Berkowitz, 2000). These are just some of the areas that Dr. Kelly Reynolds, et al, investigated during their Tucson Fire Department study**.** The purpose of the TFD study was to determine if and where within the environment of the firefighter MRSA exists.

Because the author of this paper was a co-investigator in the study, all portions presented are not a violation of copyright. The study included taking over 200 samples via swab from the firefighter environment. Certain stations were chosen due to being potentially more high-risk in nature via demographics, facility response types, or previous infection control reports. Several sites came up positive for MRSA including remote controls for electronics, station common area tables and cloth chairs, as well as classroom and secretarial environments. Out of these 'hot spots', repeat sampling was done resulting in another 150 samples taken. Once these areas were confirmed to be 'hot spots', a focused intervention was done using a product under testing. Dr. Kelly Reynolds states in her personal interview on February 7, 2007 that there are many products that will assist in the control of MRSA on hard surfaces. However, there are few products that have a full effect on soft surfaces such as couches, chairs, and other items with fabric surfaces.

Recognition and Treatment

On October 16, 2007, Lindsey Tanner, a reporter from the Chicago Tribune wrote an article that raised the immediate awareness of MRSA. In that article it stated that

> More than 90,000 Americans get potentially deadly infections each year from a drug-resistant staph "superbug," the government reported Tuesday in its first overall estimate of invasive disease caused by the germ. Deaths tied to these infections may exceed those caused by AIDS, said one public health expert commenting on the new study. The report shows just how far one form of the staph germ has spread beyond its traditional hospital setting.

The article really hit home for the American people, when it stated there were 988 reported deaths among infected people in the study, for a rate of 6.3 per 100,000. That would translate to 18,650 deaths annually (Tanner, 2007). Tanner's information was correctly taken from an article in the *Journal of the American Medical Association (JAMA).* Americans in general would probably not read this journal, so when her article hit the press, it caused quite a stir amongst the media, resulting in several other articles across the nation, and suddenly, MRSA was a hot topic.

If these deaths all were related to staph infections, the total would exceed other better-known causes of death including AIDS – which killed an estimated 17,011 Americans in 2005 (Tanner, 2007). This statement caused a stir and a flurry of articles for the next month. In a Tucson paper, there were two front page articles on MRSA-on the same day. This attention did not go unnoticed by the fire service. In November, the IAFC monthly newsletter published an article by the author of this paper based on the Tucson experience with MRSA as well as subsequent legislative changes recently passed in Arizona to make MRSA, TB and bacterial

meningitis presumptive diseases in the fire and law enforcement community. Many subsequent articles were written in national and local publications relating to MRSA in the community, particularly in the school settings. Some of these schools were closed for decontamination and cleaning.

A firefighter should be suspicious of a MRSA infection and it is recommended to seek medical advice when pimples, insect bites, cuts and scrapes become infected and to have any skin infection tested for MRSA before starting antibiotic therapy. Drugs that treat ordinary staph aren't effective against MRSA, and their use could lead to serious illness and more resistant bacteria (Mayo, 2007).

If the suspicious infection is tested, it will be sent to a lab where it will be screened for drug-resistant bacteria. In the lab, it is put into a medium where it can grow. This is called a culture, and can take as long as 48 hours. Newer DNA type testing is replacing initial tests, but is still in its infancy and is almost always backed up by smears.

Both hospital and community associated strains of MRSA still respond to certain medications. In hospitals and care facilities, doctors generally rely on the antibiotic Vancomycin to treat resistant germs. CA-MRSA may be treated with Vancomycin or other antibiotics that have proved effective against particular strains. Although Vancomycin currently works, it may grow resistant as well and some hospitals are already seeing outbreaks of Vancomycin-resistant MRSA, called VRSA. To help reduce that threat, doctors may drain an abscess caused by MRSA rather than treat the infection with drugs (Mayo, 2007). It is possible, although more rare, for MRSA to cause a necrotizing fasciitis, or "flesh-eating" bacterial infection. This type of infection can have rapid spread and can overpower a healthy immune system (WebMD, 2007).

Antibiotic therapy is created by microbes that are indigenous to nature. They secrete substances that naturally kill bacteria. According to Clemmitt (2007), "…there are three main items that allow bacteria to become resistant quickly: Speed of reproduction, exchangeability of genes with other bacteria, and tendency to mutate so their offspring can fend off future antibiotic therapies" (p. 68).

A greater fatality rate has emerged in MRSA infections that result in bacteremia. Within the hospital, Vancomycin is still somewhat effective against hospital acquired MRSA (HA-MRSA), but community acquired MRSA (CA-MRSA), which accounts for approximately ten percent of MRSA infections, is evolving so rapidly, it may soon become resistant to known antibiotic therapies (Krisberg, 2006). Tardy administration of Vancomycin, the loss in bactericidal activity of Vancomycin or sustained bacteremia inherent in some strains of MRSA can cause this. Mortality rates by *S. aureus* may be increased with reduced Vancomycin susceptibility on the bacteria. Some studies have reported an association between MRSA infections, increased length of stay, and healthcare costs. Hospitals have also observed an increase in the overall occurrence of staphylococcal infections following the introduction of MRSA into a hospital or special-care unit (CDC, 2007 October 3). Per Dr. Kelly Reynolds, there were 368,000 hospital stays due to MRSA infections in 2005, up from 175,000 in 2001. Five percent are fatal and this fatality statistic rises to 73% in the elderly (personal communication, February 4, 2008).

Dr. Brian Saltzman of Beth Israel in his article reported in the New York Post, has just completed a study of the spread of MRSA outside hospitals, and says: "We are seeing very impressive, very large, very difficult-to-treat skin abscesses. A full 50 percent of infections are

now resistant to some kind of antibiotic, whereas this was only 10 percent a decade ago." There are now three antibiotics remaining that can attack MRSA: vancomycin, daptomycin and linezolid. But those antibiotics are beginning to lose their potency against the bacteria (IAFF, 2007).

MRSA infections are treatable with antibiotics the bulk of the time, however, as noted in the above section, there are many times within the firefighter community where basic antibiotic therapy does not work. It is important that if given an antibiotic, the firefighter take all of the doses, even if the infection seems to improve. It is not recommended to take an old or another person's antibiotic, as they may be the incorrect type for the infection (W.Peate, personal communication, February 24, 2007).

Controlling MDROs in general has required a combination of interventions. These interventions can also be followed by the firefighter as well as their industrial physicians. First and foremost, include improvements in hand hygiene, use of PPE when in contact, continuing education, enhanced environmental cleaning, and improvements in communication about patients with MDROs within and between healthcare practitioners (Seigel, et al, 2006).

Centers for Disease and Control

The CDC issued the five "C's" to assist with remembering the necessary steps in the control of MRSA infections They are listed here with additional recommendations provided by Dr. Wayne Peate, MD, MPH from his personal communication February 24, 2008.

- Close Contact (skin-to-skin): Fire service leaders must press for the use of PPE on medical calls and whenever there is close contact with patients. PPE must be continually researched and improved.

- Contaminated Items: The decontamination of equipment (including turnouts) according to proper procedures and guidelines is necessary while providing for proper areas and equipment to do so is also critical.
- Crowding: Living within a 'common' environment puts firefighters at an increased potential for clustering of infections. Proper personal hygiene and following of policies will help to stem this.
- Cleanliness: Station and equipment cleanliness has always been a source of pride for firefighters. This tradition should be noted as a positive step in keeping personnel safe and be propagated throughout the department and fire service.
- Compromised Skin: Leadership at the personal level will help ensure that members cover and protect compromised skin. It is very common for firefighters to have secondary employments that are traditional vocations. These other activities, not to mention life in general can result in open wounds. To protect the patient, themselves and co-workers, proper coverage of wounds and use of uniforms that can assist in covering the susceptible area should be employed (CDC, 2007, November 27).

People who get tattoos may be at increased risk of getting MRSA. In a WebMD article reviewed by Louise Chang, MD, a warning to choose the correct artist is critical. CDC officials say people considering a tattoo should be aware of the potential risk of drug-resistant MRSA infection associated with unlicensed tattoo artists. The use of licensed artists is highly recommended.

Scientists are working on a vaccine against drug-resistant staph bacteria such as MRSA and when it comes to fruition, it will be a strong recommendation to vaccinate the firefighter/first responder population (Hitti, 2006).

Hospitals and MRSA

According to an Institute of Medicine report last year, 80,000 people die each year in the United States from hospital-acquired infections (IAFF, 2007). Hospitals are combating MRSA infections by watching closely for outbreaks and also buying antibiotic coated invasive materials, which are more expensive, but are also very helpful in keeping the source areas more bacteria free (Scowen, 2007). Ventilation is also an issue. Hospital Engineer Carl Rayton states in Kane's article in the September 2004 edition of *Hospital Development*, "Air stratification would isolate germs which come from the human body and move them upwards. If you have ventilation above the bed, it brings the germs back down to the public area" (Kane, 2004). The same article also posits that this could result in a 40% reduction in overall infections (Kane, 2004). Siegel, et al, (2007) include in their research that positive pressure airflow from the patient room to the hallways is another method of air stratification. They also recommend no carpeting, dust producing cleaning methods or upholstered furniture.

As early as 1995, nursing homes began to require hospitals to culture patients for MRSA and put on a course of antibiotics in a new "Best Practice Guideline" prior to allowing admittance (Bruck, 1995). Hand washing is a very important aspect of infection control in the hospital setting. Frequency of hand washing has been shown to reduce disease transmission (CDC, 2002).

In the Arizona Daily Star of 9/18/07, a story from London states that the British hospital system is beginning the banning of neckties, jewelry, fake fingernails, long sleeves and their traditional white lab coats to assist in the stopping of deadly hospital borne infections. The issue at hand in the article is that of housekeeping. Some of these items, such as neckties and lab coats are not regularly laundered, providing the breeding ground for the bacteria and a vector for spread. The new standards come on the heels of a 2004 study on neckties where nearly half were found to harbor at least one of the deadly antibiotic-resistant bacteria including MRSA (Daily Star, 2007, September 18, p. A4). This is affirmation that not only hospitals, but all healthcare workers may also be passing on these types of organisms. Seigel, et al, (2007) states: "The effectiveness of hand hygiene can be reduced by the type and length of fingernails. Individuals wearing artificial nails have been shown to harbor more pathogenic organisms" (p. 49).

There are three levels of decontamination. *High-level* disinfection is designed to destroy all forms of microbial life, unless there is an unusually high level of bacterial spores. High-level Environmental Protection Agency (EPA)-registered sterilant chemical such as Cidex OPA are used for this process. This process is to be used for the reprocessing of any medical device that comes into regular contact with a patient's mucous membranes or non-intact skin, such as laryngoscope blades. It is important to realize that these agents should <u>not</u> be used on environmental surfaces (West, 2007).

"*Intermediate-level* disinfection is designed to destroy viruses, vegetative bacteria, *Mycobacterium tuberculosis* and most fungi" (West, 2007, p.1). This process differs in that it will not kill bacterial spores. Bleach and water at a 1:100 dilution (¼ cup bleach per gallon of water) is an intermediate-level agent. This level of disinfection is best for items that come into

contact with intact skin of either the patient or provider, such as blood pressure cuffs, stethoscopes, and splints.

Low-level disinfection is designed to kill some viruses and fungi. Solutions in this category are often termed *hospital disinfectants* and are registered by the EPA (West, 2007). Dr. Kelly Reynolds stated in an interview that there is no other place to start looking for the proper disinfecting solutions other than the EPA list (K. Reynolds, personal communication, February 4, 2007).

Siegel, et al, (2007) describe an infection control and prevention program as a "multidisciplinary program that includes a group of activities to ensure that recommended practices for the prevention of healthcare-associated infections are implemented and followed by HCWs, [health care workers] making the healthcare setting safe from infection for patients and healthcare personnel" (pp. 134-135). MRSA control success stories testify to the importance of having a dedicated and knowledgeable team of healthcare professionals who are willing to consistently work toward surveillance and prevention strategies and policies (Seigel, et al, 2006).

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) is the national accrediting agency for hospitals and other healthcare institutions. To become accredited, an institution must meet five components of an infection control program:

> 1) *surveillance*: monitoring patients and healthcare personnel for acquisition of infection and/or colonization; 2) *investigation:* identification and analysis of infection problems or undesirable trends; 3) *prevention*: implementation of measures to prevent transmission of infectious agents and to reduce risks for device- and procedure-related infections; 4) *control*: evaluation and management

of outbreaks; and 5) *reporting:* provision of information to external agencies as required by state and federal law and regulation (Siegel, et al, 2007, p.135).

Hospitals should have an infection control practitioner (ICP) and one of their duties should include monitoring MDRO status (Siegel, et al, 2007). This would also include cleaning staff that are properly trained and knowledgeable in cleaning techniques.

Within hospitals, it has long been known that contaminated clothing can increase the risk of pathogenic disease spread. This risk can be reduced to negligible levels if these items are handled properly by staff. Siegel, et al (2007) point out three key principles for handling soiled laundry: "1) not shaking the items or handling them in any way that may aerosolize infectious agents; 2) avoiding contact of one's body and personal clothing with the soiled items being handled; and 3) containing soiled items in a laundry bag" (pp. 61-62).

Fire Departments and MRSA

There is an 'awareness' of MRSA out there as evidenced in this quote from IAFF General President Harold A. Schaitberger. "Following universal precautions with every patient contact, including hand washing, is very important – regardless of whether or not the patient's disease status is known. What you can't see may kill you" (IAFF, 2007). While this is a good sign that leadership at the highest levels is aware of the dangers of MRSA, only basic premises of prevention and protection have been issued. This is of course important as it will always be recommended that basic measures such as hand washing be undertaken.

A regular cleaning schedule should be developed and followed, with areas such as door handles, remote controls, headsets, and steering wheels given special attention. MRSA can survive on warm/moist surfaces for unknown/extended periods of time. Exercise equipment

should also be wiped down and then sprayed with a disinfectant. Cleaning equipment after each use has been proven to help halt the spread of CA-MRSA (Williams, 2006).

Turnout cleanliness is another essential step to limiting MRSA infections. NFPA standards can assist departments in the area of turnout wearing and cleaning procedures. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program (2007)*, NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting (2007)*, NFPA 1851 *Standard on Selection, Care and Maintenance of Protective Ensembles for Structural Firefighting and Proximity Firefighting (2008),* NFPA 1581, *Standard on Fire Department Infection Control Program (2005)*, Occupational Safety and Health Administration (OSHA) standards regarding infection-control programs; and manufacturer guidelines are all guiding documents. Tucson Fire Department instituted a no turnout in the station policy in 2007 to assist in limiting exposure not only to infectious material, but to cancer-causing substances as well. The policy states there will be no wearing of turnouts inside the station, which in effect makes the station the 'clean area' and the apparatus bay the 'dirty area.'

The Los Angeles Fire Department (LAFD) has been keeping statistics on its members who have suffered MRSA infections. Between 2003 and 2006, the LAFD filed 136 claims for possible MRSA infection, 50 of which were diagnosed and confirmed MRSA. Of these 50, five required hospitalization for aggressive antibiotic treatment. Clusters were also identified amongst members at certain fire stations. Crews on different shifts contracted MRSA despite no known source patient contact. It was found that the MRSA in these cases was CA-MRSA transmitted to the members by surface contact of unclean work areas such as the workout rooms, bathrooms, and kitchens (Williams, 2006).

LAFD has issued new strict guidelines/standard operating procedures related to station cleaning procedures, personal hygiene, and personal protective equipment during patient contact as well as proper decontamination (hand washing with liquid soap) after every medical call. "Since these procedures have been put into place, the LAFD has seen a dramatic reduction in MRSA-related industrial injuries" (Williams, 2006, p. 2).

Phoenix Fire Department infection control physician, Dr. Sem Jou, has instituted protective procedures. Dr. Jou has educated the members relative to the benefits of cleanliness, hygiene, proper diet, rest, and the risks of neglecting these areas. Phoenix has also installed antibacterial hand cleaner dispensers in various areas of the stations, including the entryways, bathrooms, and kitchen. Dr. Jou and the PFD have emphasized prevention and education. The result has been a marked decrease in the instance of MRSA infections among members (Tucker, 2006).

Mesa Arizona Fire Department has also experienced MRSA infections among its members. During a morning drill in 2001 a MFD engineer was crawling in turnouts and soon after noticed a red bump resembling a bite on his knee. By 1500 hours the firefighter had a high fever and his knee was hot to the touch. He was sent to the hospital where he received oral antibiotic therapy at approximately 2100 hours. When no improvement had occurred the next day, he saw his primary care physician who gave him a shot of concentrated antibiotics and told the engineer to increase his oral dose of antibiotic therapy. Two days after the initial notice of injury, the engineer went to see an orthopedic specialist as he believed he may have also injured his knee during the drill. This physician recognized the condition as MRSA admitted the

engineer to a hospital for aggressive intravenous antibiotic therapy over four days (Williams, 2006).

Derek Williams, in his article *Danger in the Stations: Drug Resistant Infections*, states:

> At the Mesa Fire Department, we have issued a Medical Personal Protective Equipment Pack to our entire membership. This PPE pack consists of a fanny pack holding such items as glasses, gloves, medical protective sleeves, TB-masks, and antibacterial hand cleaner. This pack can be carried on members during every medical call to provide initial PPE as well as backup PPE to replace soiled/contaminated equipment. The PPE pack has been used very successfully within our department (p. 5).

Mesa Fire Department's system for turnout washing combines an in-house cleaning program with dedicated washers and specialty dryers for turnouts and a private contractor certified by the manufacturer for turnout repair and cleaning (Williams, 2006). They have had great success with this system, scheduling regular turnout cleaning through battalions as well as having an emergency cleaning repair system in place. This system is supported by Saturday personal protective equipment (PPE) inspections by the company officers. MFD is also considering issuing two sets of turnouts to all members. Members would consistently have a clean set of turnouts available should one set be contaminated. This also allows regular and routine cleaning of turnouts. "A system that ensures PPE cleanliness and repair not only greatly decreases the chance for exposure to MRSA and other biohazards but also ensures that the turnouts are in good operational condition at all times" (Williams, 2006).

Prevention Measures for MRSA

It is important the firefighter understand how they can be a vector for transmission from scene to scene and the wearing of personal protective equipment is crucial to preventing contamination of each other, their equipment, and subsequent patients – not to mention family members. There is ample epidemiologic evidence to suggest that MDROs are carried from one person to another via the hands of health care providers (Siegel, et al 2006). Firefighters must be on guard to prevent exposure to bacteria like MRSA or resilient bacterium and virus from spreading to each other through patient/caregiver transmission, routine workplace contact, or inadvertently taking these dread diseases home (Kistner, 2007). Washing the hands is considered the number one method to protect against infectious disease, but studies have shown compliance is low (West, 2007).

According to Dr. Wayne Peate, MD, MPH and industrial physician for fifteen fire agencies in Southern Arizona, firefighters need to practice the following to prevent contraction of MRSA at work.

- Use only their own personal items, such as combs, brushes, shavers, washcloths, towels. MRSA is easily transmitted by these methods.
- Keep wounds covered at all times, especially while working. Open wounds are the perfect environment for the bacterium to enter and flourish. “The general rule is if a firefighter has a MRSA infection, they can work as long as they keep wounds covered. However, if the wounds are open, they are often taken off duty” (personal communication, February 24, 2007).

- Wash linens, uniforms and clothing correctly. This includes hot water and bleach to kill the bacteria. This is an area where firefighters can potentially improve greatly.

  Dr. Kelly Reynolds stated in a personal communication on June 30, 2008, "Recommendations from public health agencies for washing machine temperature, simply state using the hot cycle on the washer and highest heat setting on the dryer. We are studying now what temperatures are effective."
- Wash hands. Scrub hands briskly for 15 seconds, then dry with a disposable towel, then use another towel to turn off the faucet. Also, hand sanitizer with at least 62% alcohol is effective when soap and warm water is not available (Mayo, 2007).
- Get tested if you have an infection. Ask to be tested for MRSA. This will also help to assure no improper antibiotic use.

The below items are a compilation of suggested interventions per NFPA 1521 (2008), Dr. Kelly Reynolds and Dr. Wayne Peate subsequent to the University of Arizona and Tucson Fire Department study on MRSA in the firefighter environment..

- Replace MRSA hot spots: Fabric couches should be disinfected and covered with vinyl or replaced with vinyl or leather. In either case add couches to the regular cleaning schedule.
- Ban turnouts and work boots from living quarters. All the cleaning won't help if living area is re-infected. Place a large sign in the apparatus bays as a reminder.
- Report possible skin infections early. If a red spot or bump on the skin is larger than a dime see a health care professional. Any red streaks require immediate evaluation.

- Wash your hands. Use soap and water or an alcohol-based hand sanitizer. Also, wash thoroughly. Experts suggest that you wash your hands for as long as it takes you to recite the alphabet.
- Cover cuts and scrapes with a clean bandage. This will help prevent you from spreading bacteria to other people.
- Do not touch other people's wounds or bandages unless you are wearing gloves.
- Do not share personal items like towels or razors. If you use any shared equipment, wipe it down before and after you use it. Drying clothes, sheets, and towels in a dryer -- rather than letting them air dry -- also helps kill bacteria.

Turnout gear is a specific concern here as it is laundered much less than regular duty uniforms. These pieces of clothing must be regularly laundered to help prevent subsequent infection spread.

The duration of exposure should also be kept as short as possible to achieve necessary interventions for the patient. This means, although many people may be sent to a particular call for help, only those necessary for assessment and treatment should be within the three to six foot range. This allows for minimal numbers of personnel to be in a position where they may become exposed.

Firefighters should don gowns and gloves upon room entry and discard them before exiting the patient room. This is done to contain pathogens, especially in those patients who are known to have MRSA. Double-gloving and the wearing of gowns, both of which are not regularly practiced by firefighters can place a barrier between the firefighter and the pathogen.

Strong leadership as well as pre-planning how crews will respond is equally important. It is important for company officers to assure proper levels of PPE for the given situation.

According to Seigel, et al (2006), two of three studies evaluating the use of gloves with or without gowns for all patient contacts to prevent VRE acquisition in ICU settings showed that use of both gloves and gowns reduced VRE transmission. As VRE and MRSA are both MDROs, it stands to reason that it can also help in the pre-hospital setting, especially in those environments where MRSA is known to be prevalent, via environment or patient types. Siegel, et al (2007) found that protective masks and goggles (personal eyeglasses and contacts are not a substitute) should be worn while engaging in activities such as endotracheal work and intravenous therapies, both of which firefighters engage in regularly. Mucous membrane exposure to bloodborne viruses and other infectious agents has been associated with the transmission of to healthcare personnel (Siegel, et al, 2007). Appendix A includes appropriate procedures for donning and removing PPE (Siegel, et al, 2007).

"Appropriate PPE should be selected based on the anticipated level of exposure" (Siegel, et al 2007, p.52). Table 2 shows the Tucson Fire Department Guidelines for environments and patient types that should be known as high-risk and personnel should enter with appropriate PPE. To give personnel guidance of when proper PPE is required, TFD has added a table for when particular types of PPE are required (Table 3). The data in Table 3 are a good example of what should be minimum exposure protection when dealing with all patients, but especially those listed in Table 2.

Table 2

Environment and Patient Types for Prevention of Contamination

Environment	Patient Type
Prisons	Known Communicable Disease
Skilled Care Facilities	Catheterized
Nursing Homes	IV Drug Abusers
Shelters	OPIM Present
Other Communal Areas	Respiratory or Open Wound

Table 3

TFD PPE Usage per Activity Type

Activity	Gloves	Eyewear	Mask	Sleeves/Gown
Uncontrolled bleeding	Yes	Yes	Yes	Yes
Controlled bleeding	Yes	Yes	No	No
Childbirth	Yes	Yes	Yes	Yes
Endotracheal Intubation	Yes	Yes	Yes	Yes
Oro/Nasal Suction	Yes	Yes	Yes	Yes
Cleaning Equipment	Yes	Yes	Yes	Yes
Measuring Blood Pressure	Yes	No**	No**	No**
Starting IV/Injection	Yes	Yes	Yes	No**
Cleaning Patient Area	Yes	Yes	Yes	No**

**Unless heavily contaminated by blood or body fluids (Source: TFD Manual of Operations, Section 425 p.12)

As patient care in certain situations becomes more dangerous for the firefighter, it will be necessary to use human interaction skills to assist the patient with potential feelings of embarrassment. Seigel reports two studies where patients on barrier precautions for an MDRO had increased anxiety and depression scores. "Another study found that patients placed on Contact Precautions for MRSA had significantly more preventable adverse events, expressed greater dissatisfaction with their treatment, and had less documented care than control patients who were not in isolation" (Seigel, et al, 2006). Therefore, when patients are placed on Contact Precautions, efforts must be made by the firefighting team to reduce the potential adverse effects on the patient.

The most common reason for environmental contamination with an MDRO was the lack of compliance with agency procedures for cleaning and disinfection (Siegel, et al, 2006). In one study, housekeeping personnel at hospitals were found to have a decrease in MDRO acquisition when they were monitored for compliance regularly (Siegel, et al, 2006). This is of course also critical to pre-hospital personnel. There can be no doubt that the first-line supervisor is the key. Pre-response and during response information sharing is also a critical piece of prevention. The Tucson Fire Department utilizes a series of three questions which are asked of every calling party about the patient in question.

1. Are they coughing?
2. Do they have a fever?
3. Do they have an on-going disease process?

This information is then shared via computer with responding crews. It is then expected that the officer and crewmembers will assure proper PPE is utilized on that call. If so, and there is MRSA within the environment, no exposure should occur. In serious cases where bodily fluids are obviously present, more extensive PPE such as gowns and arm sleeves should be employed. This process helps reduce the calls where crews go in blind to a situation that potentially contains MRSA not contained in Table 2.

One of the most difficult situations is when a member of a fire department is infected and there is no way to trace back the exposing environment or patient. This can result in a battle with covering agencies. This also occurred on the TFD and to combat this from happening, when crews believe they were in an environment where a potential exposure could have occurred, yet don't have a specific transmission, the reporting officer will put a '90 code' in a specific area on the report which can be subsequently queried in the future to assist with determining when and where the member was exposed.

Resources and Products

Humans have long recognized the need to disinfect items to reduce disease transmissions. Vinegar was used for disinfection as far back as the 13th century. Regular and routine cleaning of medical equipment began as early as 1970. In the 1980s, HIV, Hepatitis B and C became prevalent and strong focus to protect healthcare workers from contamination via surfaces to these and other bloodborne pathogens became commonplace (West, 2007). To prevent cross-transmission it is important to decontaminate any equipment used. The type of container used to carry equipment will determine the way it should be decontaminated. If these items are not properly decontaminated, potential exposure to MRSA and other biohazards can occur. A

disinfectant or bleach concentration can be very effective in decontaminating such equipment. However, although bleach is a broad spectrum, it must be used correctly. The CDC recommends EPA registered products over bleach, and if dilution instructions for killing MRSA are not available, use "1/4 cup of regular household bleach in 1 gallon of water (a 1:100 dilution equivalent to 500-615 parts per million [ppm] of available chlorine) to disinfect pre-cleaned surfaces" (CDC, 2008). However, it must be assured all organic materials have been cleaned from the object first. Surface cleaning has three components, a detergent, water and mechanical action. According to an article in *Hospitals for a Healthy Environment* (2006, October), the use of combination disinfectant/cleaners may cause maintenance personnel to ignore required kill times for the disinfectant portion, or cause the use of too much disinfectant. Separate products are recommended.

Spray the box/bag with a disinfectant, and *do not wipe off*. Allow the disinfectant to sit on the equipment and air dry. This is the only way to kill MRSA effectively (Williams, 2006).
It is important to understand two distinctly different terms: disinfectant and sanitizers. Dr. Kelly Reynolds states:

> The EPA regulates disinfectants and sanitizers as antimicrobial pesticides under the laws, guidance, and policies contained in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). A **sanitizer** must destroy 99.9% to 99.999 % (depending on the application- the 99.999% is for food contact surfaces and 99.9% for other surfaces). Sanitizers significantly reduce bacteria, but not necessarily totally eliminate them under test conditions. The key point in being called a sanitizer is that the product is able to work quickly- proving efficacy in

30 seconds (food contact surfaces) to 5 minutes (other surfaces). Sanitizers, for food contact surfaces, are typically evaluated for efficacy against *E. coli* and *Salmonella,* as per EPA test guidelines. Sanitizers directed for use on non-food contact surfaces, are typically evaluated for efficacy against *Staphylococcus aureus* and *Klebsiella pneumoniae.*

A **disinfectant** inactivates 100% of all actively growing bacteria, achieving greater than a 99.99% kill rate of bacteria. Disinfectants are typically evaluated for efficacy against *Salmonella choleraesuis* and *Staphylococcus aureus*. Additional testing against *Pseudomonas aeruginosa* is required for hospital or medical environment applications. To achieve such complete inactivation, product labels typically recommend increased contact time, usually 5-10 minutes. Based on EPA test requirements neither of these labeling terms specifically addresses viruses or other known bacterial pathogens. Other organisms may be evaluated with disinfectants but products are required to achieve a >99.99% reduction in 100% of the test replicates in order to be approved to list those organism specifically on the disinfectant label. This list can be found at: http://epa.gov/oppad001/list_h_mrsa_vre.pdf (personal communication, February 4, 2008).

There are four main types of chemicals used to control microorganisms, they are alcohol based, (either isopropyl or ethyl), benzalkonium based, quaternary amine based, or sodium hypochlorite (bleach) based. Each of these products is effective in its own way, but the user must answer a few key questions such as: Is there a large amount of organic material present? If so,

this must be taken into account and dealt with prior to actually applying these products for the kill factor. The larger, soiled areas must be wiped clean prior. Another question that needs to be asked is "how much time do I have"? The reasoning behind this question is because some products ask for up to 20 minutes of "wet time" to achieve their stated kill rates.

There are also new metal based products, and in San Diego, the environmental technology company PURE Bioscience, donated 200 gallons of Staph Attack™ a silver-based hard surface disinfectant that is registered with the EPA against MRSA to EMS, Fire Department, and Police personnel in the city of San Diego. "We greatly appreciate a local company stepping forward to help address a serious health threat in our city," stated San Diego Fire Chief Tracy Jarman. "Anything we can do to stop the spread of MRSA by creating a cleaner environment for the individuals coming into contact with the infection on a daily basis is a great asset not only to our teams but to public health as a whole." Silver dihydrogen citrate (SDC), the patented active ingredient in Staph Attack™, is an electrolytically generated source of stabilized ionic silver. The bacteria look upon the molecule as a food source, and when the organism consumes it, SDC destroys the bacteria by disabling proteins and stopping its metabolic and reproductive functions. SDC provides 24-hour residual protection as well (MRSA Note Archives, 2007, January).

Staph Attack™ is a fairly new product on the market, and is a silver-based broad spectrum disinfectant and deodorizer being marketed to hospitals and institutions. Tulsa County Jail is using it and according to Tulsa County Sheriff, Stanley Glanz, "We have been fighting Staph infections for some time now, and in our best efforts using previous products, we were unable to contain or stop the presence of MRSA. Since we started using Staph Attack ™ two

months ago, we have not had one new case of bacterial infection, including MRSA" (MRSA Note Archives, 2007, January).

Another new area of germ control is the utilization of oxidizing agents. ACME, Inc. demonstrates a three phase cleaning and protection system with a first phase that cuts through grease and heavy soil with an oxidizing agent that also accomplishes initial decontamination. It is a broad spectrum based disinfectant, which means it kills a wide variety of germs and when using a broad spectrum product it is important to read the label for the exact germs you are attempting to kill (K. Reynolds, personal communication, July 25, 2008). Phase two of the process uses a photo-catalytic oxidizer, which is ultra violet rays and photons that produce a vapor that disinfects airborne and surface pathogens (ACME, 2008). The third phase is an application of a hygienic coating spray that removes organic matter necessary for bacterial growth (ACME, 2008).

The alcohols are mainly used for the disinfection of hands and hard surfaces in the form of hand sanitizers. DuPont® has a product called RelyOn™ which comes in various forms for different applications. The antiseptic hand spray has 70% isopropyl alcohol, which is above the 62% minimum. This extra 8% allows for the killing of TB and the Hepatitis Viruses A, B and C. As an example, the GOJO product Purell™ hand sanitizer contains ethyl alcohol, but at a 62% figure, not allowing for it to claim kill rates on TB, or the Hepatitis Viruses (DuPont, 2005). DuPont also has a multi-purpose disinfectant cleaner that is per oxygen based and when dissolved in proper amount of water, will produce a 1% solution for cleaning of hard surfaces.

Antibacterial soap is a popular household item. However, Aiello, et al, discovered there was no difference in the reduction of bacterial infections with the use of products containing 0.2% triclosan, the active ingredient (Aiello, et al, 2005). Regular soap had the same efficacy.

One other product that is beginning to get noticed is Zimek Dri-Mist™. It is currently being used by Homeland Security, police departments, jails and some fire departments in the European Union. Dri-Mist™ is a vaporous flurry of sub-micron particle "bullets" of disinfectant that can kill MRSA, Staph, Hepatitis C, TB and the Bird Flu virus (H5N1). It is also regulated by the EPA as a disinfectant. The particles have been negatively charged with a low surface tension. This allows for it to bind to surfaces as most are positively charged. It does not harm metals or electronics. The product is delivered through a machine that aerosolizes the product and is taken back up by the Zvac machine when treatment time is done. Zimek Technologies recommends treating ambulances once every 30 days. They estimate the cost to be around $3.00 per ambulance (Airpro, 2008).

A team of researchers at Auburn University's Samuel Ginn College of Engineering has developed a new type of 'coating' for items that potentially can spread disease in hospitals, nursing homes, schools, and gyms. Solutions of lysozyme, a natural product with antimicrobial properties found in egg whites and human tears, were mixed with single-walled carbon nanotubes (SWNT), which are microscopic pieces of carbon. These SWNTs, are one nanometer in diameter (one-billionth of a meter), and a perfect cylinder of carbon and are able to keep the lysozyme intact within the coating. SWNTs are among the strongest materials known to man (OS&H, 2008).The key to this product is that right now, wet times (the time necessary to achieve the stated logs of reduction or kill rate) is a deterrent for the fire service in that these times are

around ten minutes. This product is inherently antimicrobial, which means wet time becomes unimportant (OS&H, 2008).This could mean the equipment and materials used by firefighters may be coated with this product and have a dramatic reduction in potential cross contamination issues.

Successful prevention and control of MDROs requires administrative and scientific leadership and a financial and human resource commitment. Resources must be made available for infection prevention and control, including expert consultation, laboratory support, adherence monitoring, and data analysis. Infection prevention and control professionals have found that healthcare personnel (HCP) are more receptive and adherent to the recommended control measures when organizational leaders participate in efforts to reduce MDRO transmission (Siegel, et al, 2006).

One area that can provide a measure of control against all types of micro-organisms is station design. Products that can control MRSA are only effective on hard surfaces. There are no products currently that can kill MRSA on soft surfaces (K. Reynolds, personal communication, February 4, 2008). There are many types of fabric that can be used on furniture in the station which is considered a “hard” surface where products can be used. As a result of the Tucson study finding that most of the MRSA found in the stations was on sofas in the day rooms, the Tucson Fire Department began using a product called Rave ™ with PermaBlock3®. It allows for the use of ammonia, products such as Formula 409® and Fantastic®, as well as 1:4 bleach and isopropyl alcohol at a 1:1 ratio. It even allows straight naphtha such as lighter fluid for small areas. The leather-type material also has an anti-microbial, and anti-bacterial layer below the surface of the top layer, which prevents deep seating of germs as was found in the soft furniture at TFD stations.

Subsequent testing by Dr. Reynolds' team has failed to produce a positive result for MRSA on these pieces of furniture with the new covering (K. Reynolds, personal communication, May 19, 2008).

Another control method that can be used is stainless steel. "Metals are a natural barrier to bacterial growth" says Dr. Kelly Reynolds in an interview on February 4, 2008. "Metals actually are used in the control of bacteria and other micro-organisms in other forms." Soft surfaces should be avoided when building or remodeling stations as they can be more easily cleaned by today's products that are effective on MRSA and like organisms.

Legislation on MRSA

If a MRSA infection was to render a firefighter or first-responder unable to perform duties of their position, would they be covered? If the case of the first firefighter MRSA death in Texas is any indication, the answer is not unless you can prove where you were infected. According to department personnel it is not looking good for the firefighter's family to receive Line of Duty Federal Compensation.

MRSA has, however, made its way to the top of the legislative world. On January 13, 2008, the office of Senator Robert Menendez, D-NJ issued a press release in *US Federal News* that he has introduced the "Protecting Workers from Infectious Agents Act" and the "MRSA Infection Patient Protection Act" to the Senate. It is designed to achieve a new Occupational Safety and Health Administration (OSHA) standard to protect those employees who are either exposed to or work with drug-resistant infectious materials during the course of their duties, including police, firefighters, emergency responders and other workers. The bill is co-sponsored by Senator Ted Kennedy, D-MA and Senator Richard Durbin, D-IL.

A subcategory of this legislation is the MRSA Infection Patient Protection Act that would require hospitals to pre-screen certain individuals who are deemed to be high-risk for the MRSA infection. By screening Intensive Care Unit (ICU) patients, being required to report MRSA infections to local, state and federal authorities and requiring non-hospital institutions to report these infections, the bill hopes to lay the political and legal foundation for dealing with this national health care crisis (Menendez, 2008). Dr. Howard Rodenberg, MD, MPH wrote in the *Journal of Emergency Medical Services* in January 2008:

> Diseases are usually reportable to health authorities when they are rare, easily transmitted between susceptible persons and have high rates of complications. Reportable diseases also mandate investigation to prevent further infection. In some ways, MRSA was a candidate to be a reportable disease a number of years ago, but now it's so common and well-known that the horse has left the barn, and not much can be gained from further review. And even if we want to begin reporting MRSA infections, Dr. Gail Hansen (the Kansas state epidemiologist) reminds me that part of the problem is deciding exactly what reporting actually means. Is it designed to detect outbreaks, study risk factors for infection, determine the prevalence of MRSA in the community, or provide accountability measures for hospitals and other health care facilities? Each of these goals requires different surveillance systems and different sets of data. The Council of State and Territorial Epidemiologists (CSTE) has issued a position paper supporting pilot research to outline what a surveillance and reporting

system for MRSA might look like. Unfortunately, it seems that both legislators and the public want instant, rather than valid, information (Rodenberg, 2008).

In Arizona, Governor Janet Napolitano signed Senate Bill 1127, into law on May 24, 2007. The bill amends Title 23, Chapter 6, Article 8, in the Arizona Revised Statues by adding section 23-1043.04; relating to workers' compensation: Methicillin-resistant staphylococcus aureus; spinal meningitis; tuberculosis; establishing exposure; definitions (Workers Compensation Infectious Disease Exposure Act, 2007). This bill makes it presumptive if a firefighter (and other first responder) is diagnosed with MRSA, spinal meningitis or tuberculosis. This was a huge step in the recognition of this issue by legislature and most likely will have an impact on the newer federal legislation described above.

On August 20, 2007 in Illinois, Governor Rod Blagojevich signed Public Act 095-0312, the MRSA Screening and Reporting Act, which calls for hospital-based screening, isolation and reporting to public health agencies those Intensive Care Unit (ICU) patients diagnosed with a MRSA infection. While this affects firefighters and first responders in an indirect manner, it is the beginning of prevention efforts, as it will then translate to potential information sharing with pre-hospital providers if the patient needs assistance subsequent to returning home (MRSA Screening and Reporting Act, 2007).

It can be concluded that there is a large amount of information and many different products available to fire departments to control MRSA. The technical knowledge required to understand how to control MRSA as well as knowledge about general infection control within the firefighter's environment has also improved. It is important to also be aware that different products work in different ways and while the average firefighter is not an expert in this area,

they are relying on those within any emergency response organization to be the experts and give them what they need to protect themselves. This lends itself to the conclusion that all organizations must appoint someone who can stay on top of this area of concern. The OSHA General Duty Clause may apply should this not occur. Information sharing is a key to the fire service having the latest updates available in these areas and it behooves the emergency organizations to work together and share any information with others as there are many who cannot afford specialists.

Procedures

The methodology used in this research project included collection of 2001 to 2006 reported exposures and injuries resulting from MRSA using TFD data, personal interviews with the TFD medical staff, a questionnaire, and a literature review. The data were collected with coordinated effort from the TFD Industrial Physician and the TFD Health and Safety Office. Extensive communication was achieved with the TFD medical staff as well as the researchers from the University of Arizona. The literature material included sources from the Internet, library, communicable disease books and the National Fire Academy library located in Emmitsburg, Maryland.

Research question one was answered via the literature review and by reviewing multiple articles on the Center for Disease Control website. Unstructured phone interviews were also used to confirm and have explanation of terms and issues relating to MRSA as well as the firefighter environment.

The second research question was related to healthcare institutions and most of the information was derived from literature review and discussion with interviewees again to elicit a

better understanding of terminology and the hospital environment. This was compared by the author to the literature review for question one.

Research question three was asked to get an understanding of what fire departments across the United States were doing to mitigate the problems associated with MRSA. The questionnaire described below and the literature reviews were the main tools used to derive this information. Questions on the questionnaire were broken down into three main areas of inquiry: education, engineering and enforcement.

Question four was also answered by a questionnaire sent internally to Tucson Fire Department personnel as well as a review of TFD policies and procedures. Again, the three areas of education, engineering and enforcement were how the questions within were broken down.

Questionnaire

The questionnaire was created using yes/no, Likert scale, and comment entries by the respondents to ascertain data that would assist in answering three of the four research questions. Question number two, which reads "What are healthcare institutions doing to mitigate the risk of MRSA?" was answered mainly through literature review and personal interviews.

The author used the United States Fire Administration (USFA) website to retrieve statistics on fire department sizes across the nation. The Tucson Fire Department has 700 employees as of January 2008 (TFD, 2008). On the USFA spreadsheet, the author used the filter mechanism to refine out departments according to number of personnel. This was done so accuracy of response to the questionnaire was maintained. This resulted in only seven departments with very similar numbers of personnel to TFD. The author used departments with two hundred more personnel and two hundred less personnel, so enough data could be retrieved.

A list was created of departments who had personnel numbers between five hundred and nine hundred. Out of the 33 departments on the list, the author attempted to phone each one and ask to speak to the person that could answer questions regarding that department's infection control policies, procedures, and data. Twenty-seven departments answered or returned phone calls after a minimum of three attempts, resulting in a total of 27 departments being sent the questionnaire (Appendix A). Two subsequent requests were sent to these twenty-seven departments and a total of 18 questionnaires were returned for a 67% rate.

An internal questionnaire was also created and sent to randomly chosen Tucson Fire Department personnel. This was done utilizing entire crews to ensure proper proportions of each rank were involved. Personnel holding single resource positions were also chosen randomly and sent the questionnaire. Non-commissioned personnel who are employed at each facility were included to assure all membership areas were involved. A total of twenty-five personnel were sent the questionnaire with 24 responding for a 96%, considered excellent by Babbie (2008).

The data were collated using the City of Tucson Survey Tool and placed into the tables referenced throughout this research. These tables can be found in the Results section.

Interviews

Personal interviews and communications were conducted with Dr. Wayne Peate, MD, MPH on February 24, 2008. Dr. Peate was asked numerous questions, including the general topic of MRSA, how it has affected firefighters he has treated, and what mitigation therapies should firefighters employ to reduce the risk of MRSA infections. He openly responded to all, and elaborated to include other subject matter related to MRSA. Dr. Kelly Reynolds, PhD, MSPH was interviewed on February 4, 2008, July 25, 2008 and other subsequent communication via

emails. Dr. Reynolds was asked questions relating to products, the Tucson Fire Department/University of Arizona Study, and the science behind MRSA. Other information was retrieved via email conversation and questions.

Limitations

Limitations of the project were based on Health Insurance Portability and Accountability Act Of 1996 (HIPAA) guidelines as personal medical information cannot be shared with other than those directly involved in care. It was difficult to gain information on specific cases of MRSA to use for analysis. Also, few articles have been written with regard to the fire service and the topic of MRSA, therefore a correlation and transfer of information from the other areas of healthcare had to be made.

Delimitations

This paper was focused on finding a standard response to MRSA mitigation for the Tucson Fire Department and was not designed to critique TFD's or other fire department's infection control programs. This study is not intended to study MRSA in the hospital environment although it is important to firefighters since they are often in the hospitals delivering patients and treating those recently released.

Results

Research question number one asked what the Centers for Disease Control (CDC) recommended to mitigate the risk associated with MRSA. The literature review reveals that there are numerous articles on the CDC website, all with valuable information. Eighty-three percent of responding departments stated they use the CDC as a guideline for infection control. Ninety-six percent of Tucson Fire respondents indicated they are familiar with the CDC.

The CDC recommends many measures to reduce the risk of disease transmission and uses the five "C's" to guide the public. The five 'C's' can be applied to the fire service directly per Dr. W. Peate's communications. Although 83% of departments responding stated they used the CDC as a guideline, only 27% responded in the affirmative that they had policies regarding environments such as nursing homes, long-term care facilities and jails, which produce close quarters (crowding) and contact, which are both part of the five 'C's. As noted in the literature review and Table 2, TFD has a policy outlining the specific areas/environments to be cautious in with regard to infection control (TFD, 2004). One TFD respondent stated in the open comment area of the questionnaire, "As a Captain, when responding to a MRSA pt, especially at a Care Facility, I stay out of the room to minimize my exposure and avoid the need for full PPE. When entering a Care Facility, I and my crew assume that everyone has MRSA, c-diff, VRE and everything else even if not advised of such on the MDT [Mobile Data Terminal]."

The CDC states that the number one deterrent to infectious spread is the washing of hands (CDC, 2002). Sixty-one percent of national responding departments said they had policy for when personnel must wash hands. Sixty-seven percent of Tucson Fire respondents stated the number one way to prevent MRSA was to wash hands. Responding departments indicated 62% have signage around facilities to assist members in remembering to wash their hands. Keeping hands clean between calls can be more difficult. Table 4 below breaks down the responses to the TFD questionnaire regarding the use of anti-septic hand gels and the washing of hands.

Table 4 Washing hands and hand gel usage by TFD members

Hand Gel		Hand washing	
After each call	29%	After each call	54%
Only used sometimes	41%	After using restroom	83%
Never use	17%	Prior to cooking	70%
As a substitute for hand washing	4%	Even if used hand gel	54%
Always wash hands after use	29%		

Cleanliness is another one of the five "C's" from the CDC. Table 5 organizes the questionnaire responses from national agencies regarding this. National department respondents indicated they have policies for cleaning of turnouts (100%), cleaning of regular duty uniforms (62%), cleaning of apparatus (78%), cleaning of medical equipment (89%), and cleaning of station (50%).

Fire departments and TFD respondents indicated stations are cleaned by uniformed personnel (100%) and not professional services. One TFD respondent in the open comment area gave this response: "Better, more specific policies about how to clean what, for example, what material and what components of the medic truck on each call, what items around the station provide the most benefit, suggestions for cleaning methods around the station, etc."

Turnouts are cleaned less often due to the potential for breakdown in the protective fabric (NFPA 1851, 2008). Respondent fire departments indicated they clean their turnouts and uniforms by regular washing machine (50%), extractor (61%), or dry cleaning (11%). Dryers are used 39% of the time and open air drying is used 50%. TFD respondents indicated they launder

their turnouts at the station 75% of the time with 4% alternating between home and station. Sixty-seven percent of TFD personnel responding wash their duty uniforms at the station. One civilian employee for TFD stated in the questionnaire open comment area, "As a civilian employee we receive little to no training in any of these areas. TFD should provide laundry services for civilian employees who perform maintenance on the fire apparatus and medic units, they are required to take their uniforms home for washing, no wash facilities or services are available."

Another of the five "C's" from the CDC is contaminated items. Wearing of turnouts into the station environment is a potential vector for transmission. TFD personnel indicated they wear turnouts to medical calls sometimes (46%), only during physical training (21%), and during nighttime calls (4%). They also responded (8%) that they wear their turnouts into the station. National departments indicated (57%) that personnel wear turnouts in the station. One TFD respondent indicated in the open comment area of the questionnaire that "Maybe the use of nomex 962 pants instead of Firefighters using turnout pants. Firefighters are more likely to wash those pants on a regular basis than turnouts."

Research question number two asked what healthcare institutions are doing to mitigate the risk of MRSA infections? This question is answered mainly through the literature review. Hospitals and healthcare institutions do many things to mitigate the risks of infectious disease as they have dealt with MRSA for a long time. One mitigation effort is to delineate clean and dirty areas. This assists with cross contamination issues. Fire department respondents indicated that 50% have policies regarding delineation of clean and dirty areas within the fire station. Sixty-seven percent of TFD respondents indicated they were aware of the TFD policy regarding clean

and dirty areas. Healthcare institutions have staff dedicated to cleaning and infection control. They are trained in proper cleaning techniques. The questionnaires indicated that 100% of the time, station personnel clean their stations and 50% of departments stated they had policies and procedures for how to clean. TFD has no policy on how to clean the stations. Table 5 indicates how often certain items found to be high in bacterial count or positive for CA-MRSA during the Tucson study are cleaned.

Table 5 Frequency of item cleaned daily with TFD provided cleaners

Station		Apparatus	
Door handles station	17%	Door handles apparatus	29%
Tables dining area	83%	Steering wheel apparatus	21%
Kitchen counters	83%	Seat of apparatus	8%
Remote controls	4%	Medical equipment	29%
Personal work area	25%		

Siegel, et al, (2007) pointed out the need for an infection control program and team. This is something both national departments and TFD personnel have by way of their infection control officers (ICO). All responded (100%) that they had a designated ICO.

Research question number three, asking what fire departments within the continental United States are doing to mitigate the risk of MRSA infections, was answered through literature review as well as a questionnaire described in the procedures section. The questionnaire revealed that the population served by respondent departments was mainly in the 500,000 to 1,000,000 range (44%) which is in line with expectations as these departments also have a larger amount of

personnel. The questionnaire was sent to departments with an employee range between 500 and 900. Of the eighteen departments responding, 78% were all-career with the remaining 22% in mostly career departments with over 50% of the personnel being full-time. This is significant in that these departments will run more calls, resulting in more exposure to communicable diseases such as MRSA.

Table 6

Respondent Demographics

National					
Rank		Assignment		Infection Control Officer	
Chief Officer	44%	Staff	72%	Staff	72%
Company Officer	44%	Field	11%	Shift	6%
Civilian	11%	Civilian/Other	17%	Civilian/Other	22%
Tucson Fire					
Rank		Assignment		Infection Control Officer	
Chief Officer	4%	Field	63%	DC 12	67%
Captain	33%	Admin	37%	DC 09	4%
Engineer	8%			EC Capts	8%
Paramedic	8%			EC 26	21%
Firefighter	25%				
Civilian	21%				

Table six describes the demographics of the respondents showing the bulk of departments have their infection control officers as staff positions (72%), with some, (22%) being civilian and not commissioned.

Table 7 describes the relationships between the questionnaire sent to the national fire departments and Tucson Fire Department as it pertains to how they feel about their respective infection control programs.

Table 7

Descriptions between national and TFD

National		Tucson Fire
	Effective Infection Program?	
Agree/Strongly Agree	94%	88% (Excellent/Good)
Disagree/Strongly Disagree	6%	12% (Fair)
	Discipline for PPE Infractions?	
Agree/Strongly Agree	57%	50% (agree in some form)
Don't Know	22%	
Disagree/Strongly Disagree	21%	

Questionnaire results show 72% of respondent departments had a physician retained to assist with managing infection control issues and 94% indicate they use NFPA 1581 as a guiding document for infection control. Tucson Fire Department has a physician intimately familiar with National Fire Protection Agency (NFPA) 1581, *Standard on Fire Department Infection Control*

Program and NFPA 1500, Standard on Fire Department Occupational Safety and Health Program.

Table eight below shows the national and TFD responses for exposures and MRSA infections.

Table 8__ Number of total exposures and MRSA diagnoses (in respondents)

National			
Exposures			
Number	2004	2005	2006
5-10	28%	22%	28%
11-50	61%	61%	50%
50-100	10%	17%	17%
Over 100	6%	6%	6%
MRSA diagnoses			
5 or Less	5%	5%	5%
Tucson Fire			
Exposures	81	93	88
MRSA diagnoses	9	8	5

(TFD, 2005, 2007)

Thirty-eight percent of TFD respondents had an exposure to a communicable disease, with 29% reporting an exposure to MRSA. Of these respondents none had a diagnosis of MRSA infection.

Seventy-two percent of departments responding indicated they had procedures in place to inform crews who are in response to an emergency scene that there are potential patient infectious disease issues. Tucson Fire has the three dispatch personnel initiated questions of fever, cough, or disease process and subsequent sharing of this information on responding units. One hundred percent of TFD respondents indicated their company officer shares this pre-arrival information with them while en route to incidents.

As it pertains to post-exposure reporting, TFD has the '90 code' for documenting potential exposures as explained in the literature review. Ninety-four percent of national departments responding stated they had some form of first-care reporting for exposures. Fifty-percent of national respondents stated they had presumptive legislation for MRSA. The state of Arizona passed a law making MRSA presumptive in 2007.

When asked about having policies and procedures for dealing with patients who present with high risk for infectious disease, national departments responded 78% in the affirmative. However, when asked if they had policies and procedures for dealing with certain environments that present with an increased risk of potential infectious disease, 28% responded positively. Tucson Fire has policies and procedures in place as indicated in the literature review (Table 2).

All national departments (100%) responded in the affirmative to having policies related to use of certain levels of personal protective equipment (PPE) and the mandatory reporting of exposures. Fifty-four percent of TFD respondents stated TFD does have policy for particular levels of PPE on certain types of calls (Table 3), 67% that TFD has policy on cleaning of PPE, and 88% that TFD has policy on the reporting of an exposure. Fifty-four percent of TFD personnel were correct in where they would find these policies within TFD manuals. Regarding

specific PPE policy when encountering a patient with an open wound, which is the greatest potential for CA-MRSA spread, national departments responded they would wear eye protection (72%) and respiratory protection (28%). When asked if their departments provided gown-type PPE for personnel, 89% responded they did, and 39% responded positively when asked if their department provided arm sleeve PPE.

Research question three asked what Tucson Fire Department is currently doing to mitigate the risk of MRSA to its personnel. When asked which of the four (education, engineering, enforcement, or attitude) makes the biggest difference with regard to preventing MRSA, 58% indicated education, 4% indicated engineering, and 8% stated enforcement. Twenty-nine percent indicated attitude makes the biggest difference. With regard to education, 79% of TFD respondents believe they have had excellent or good education in the topic of infection control, with 75% stating they had excellent or good training in MRSA. Seventy-one percent stated they had received regular education on communicable diseases with 58% stating they had regular education on MRSA. Seventy-two percent of national departments indicated they have annual training in communicable diseases, with 28% indicating they have training twice per year. Fifty-six percent of national departments indicated they have had training specific to MRSA. Sixty-seven percent of TFD personnel indicated that Deputy Chief 12 is the TFD infection control officer, a correct response. When asked what HA-MRSA and CA-MRSA stand for, only 29% of TFD respondents were correct. During education provided, it was shared that touching of the hands to face is the number one way of spreading bacteria. Respondents (79%) indicated this correctly, with 21% choosing personal articles such as cell phones.

Engineering practices such as pre-arrival questioning are in place and 71% of TFD respondents indicated they were aware of this. TFD provides all necessary PPE to reduce risk to potential communicable diseases and 83% of respondents indicated they agreed with this. Seventeen percent of respondents stated they will wear two sets of gloves on incidents involving high-risk for MRSA exposure. Seventy-one percent indicated they do not require their supervisor to tell them when to put on appropriate levels of PPE.

Policies on reporting of exposures including MRSA are contained within TFD manual of operations. Eighty-eight percent of TFD respondents indicated they understand policy requiring reporting and 83% state they feel comfortable reporting an exposure. When asked if signs indicating clean and dirty zones or hand washing reminders were used, how likely would it be effective to mitigate infectious disease spread including MRSA, 29% believed not likely, 50% thought it to be somewhat likely, 13% likely, and 8% very likely. The CDC (2002) recommends not sharing personal items such as bar soaps, towels, razors, etc as a mitigation strategy against MRSA spread. TFD respondents indicated (33%) they used pump operated soap only, with 67% indicating they used both bar soap and pump operated.

Enforcement is the third area of mitigation strategy. In the national questionnaire, 57% of respondents stated their departments would discipline personnel for infection control practice infractions. Sixty-seven percent of TFD respondents indicated they should be expected to follow PPE policy. Four percent indicated personnel should have the personal right to choose if they wear PPE on medical calls, with 4% indicating they should wear the same PPE on all calls as a standard mitigation procedure, and 8% stating they should not be expected to wear PPE on calls as the primary way to reduce risk to exposure. One TFD respondent indicated in the open

comments section “The difficult part, I think, is dealing with complacency. We are all adults and know better, but people still think they don’t need the PPE for whatever reason.” When asked what their feelings would be regarding a junior member telling them to put on appropriate PPE, 63% of TFD respondents indicated they would be thankful and 13% indicated it would be expected. Thirty-eight percent of TFD respondents indicated they always feel comfortable telling a more senior individual to put on proper PPE, with 42% indicating sometimes, and 20% stating they never feel comfortable. Seventy-one percent of TFD respondents indicated it is each individual’s responsibility to ensure proper PPE is worn. Thirteen percent indicated it was the company officer’s responsibility, and 4% stated it was the chief officer’s.

Discussion

The discussion section of this paper will be organized using the three ‘E’s’ (education, engineering, and enforcement). It is the author’s belief that these simple words, while normally applied to fire prevention activities, can be applied to numerous other areas within the fire service. It will also serve to correlate, compare and explain the results of the study in a fashion that readers within the fire service can relate to, making it easier to understand and apply.

There can be no doubt that a problem exists and is on the rise. Hitti (2007) found a seven times increase in CA-MRSA infections during the years studied and the Association for Professionals in Infection Control and Epidemiology estimated that 1.2 million hospital patients are infected annually and another 400,000 plus are colonized (Mayo, 2007). In the hospital, the HA-MRSA and CA-MRSA infections resulted in twice the admissions between 2001 and 2005 (Reynolds, 2008). Although CA-MRSA kills the young and healthy, the fatality statistics rise to 73% in the elderly diagnosed. The Journal of the American Medical Association reported also

that nearly 19,000 deaths annually can be attributed to MRSA, which is more than AIDS killed in 2007 (Tanner, 2007). Dr. Saltzman's findings of the spread of MRSA outside the hospital as seen by practitioners in very difficult to treat skin abscesses up from 10% of total cases to 50% corroborates this. The firefighter engages in multiple areas where MRSA can be harbored such as nursing homes, jails, schools and other facilities where crowding is an issue. MRSA Resources (2007) reported the death of a college football player who by nature of the sport was in crowded and close contact conditions. Hitti (2007) found that poor hygiene and crowded living conditions are at an increased risk of housing the CA-MRSA organism. The Mayo Clinic article (2007) pointed out that they found MRSA to be even more prevalent in these types of environments that within the hospital. Wilmoth's blog "Sick Fire Stations (2007, July 20) points to a California department where nine firefighters were afflicted with a stubborn infection of which two were diagnosed as MRSA. Table 8 shows that total exposures to communicable diseases are on the rise nationally, but there does not appear to be an increase in the number of MRSA diagnoses within the fire departments responding to the questionnaire. TFD personnel have already experienced exposure and treatment for MRSA as shown in Table 1 (WellAmerica, 2008). The cost to the department was not only the initial office visits and consults, but the hospitalization and treatment and ultimately, the lost productivity as members were away from work until successful treatment (WellAmerica, 2008). Not only have they been exposed and treated, but at least one member's claim was denied and it can be reasonably posited that the member then passed the infection to their daughter (Peate, 2007). The problem is also evident in the fact that at least one MRSA related death has been reported in the fire service (Dallas Morning News, 2007, November 18).

MRSA was found in the emergency provider environment as evidenced in the *Journal Watch Emergency Medicine* article that found 48% of the ambulances tested were positive for MRSA. The fact that other departments such as Los Angeles, Phoenix, Mesa and San Diego also have had a problem with MRSA confirms it is in the firefighter's environment. The Tucson Study further proved this as several items within the firefighter's living environment also tested positive for MRSA (Reynolds, 2008). This can result in an indirect transmission according to Berkowitz, (2000) and the passing on to other environments such as home or other patients.

Education is always the first of the 'E's to be employed. It is critical that personnel be given the information and knowledge necessary to be able to apply it within their environment. They must understand the why, and not rely on 'just because' as a reason. This will assist with buy-in as appropriate changes are made. It is critical the fire service begin a strong educational push with regard to the topic of MRSA. The author found this to be true in that there were no Advanced Research Projects in the library at the National Fire Academy on the topic of MRSA and only one abstract on communicable diseases. This is also evidenced in the results of the questionnaire where only 56% of national respondents indicate they have had training specific to MRSA. One-hundred percent of TFD firefighters have had education on MRSA via continuing education sessions, communications through Master Memorandums and Daily Bulletins, and more recently an online education tool through the City of Tucson Employee University (COTEU). When asked which of the 3 'E's was most important, 58% stated education, but attitude was second with 29%.

There appears to be a dearth of knowledge in some areas concerning MRSA even though TFD has had numerous educational opportunities. This is corroborated in that only two-thirds

(67%) knew who the TFD infection control officer was and only 54% of TFD respondents stated they washed their hands after every call, the number one mitigation strategy (CDC, 2002). Although TFD personnel knew what the CDC stood for, only 29% knew what HA-MRSA and CA-MRSA stood for, a topic that has been covered through educational sessions and memorandums. Ninety-four percent of national departments stated they had an effective infection control program. Eighty-eight percent of TFD personnel rated their program excellent or good indicating personnel have a strong faith in the program, indicating TFD is on the right track.

One area within education that can be improved upon is the topic of cleaning. Healthcare institutions have dedicated staffs that are trained in proper use of cleaning materials and methods. All national and TFD respondents indicate uniformed personnel are the ones engaging in the cleaning of their environment. This coupled with the response that only 50% of departments have policies and procedures for properly cleaning and that TFD has no actual policy or procedure other than to follow manufacturer's suggestions on product use, points out that this is an area that can be definitely improved upon. The data in Table 5 indicates how often TFD personnel clean particular areas of their environment on a daily basis where the Tucson Study found MRSA and other contaminants. This is a need based on the open comment by a TFD member asking for more engineered policies and procedures for cleaning of the station and equipment. This can be improved upon by educating personnel to the need for not only cleaning in certain ways, but using the products appropriately. It will also be important to educate personnel on a personal level such as Chang (2006) describes with tattooing. This is a popular trend and firefighters appear to be taking part in it, but where appropriate, these items should be

shared as safety bulletins or other communication to assure personnel are made aware of the risks.

The department infection control officer (ICO) is the person usually responsible for disseminating infection control information. Respondents nationwide indicated the majority (94%) have an infection control officer who is in a staff or civilian position. TFD is in line with this as its ICO is a full-time and dedicated staff position. Seigel, et al (2007) also states the importance of the infection control program is. A physician familiar with the appropriate NFPA standards is a key to guiding departments on infection control education and issues. According to Seigel, et al, (2006), it is also important that the treating physician is well aware of the current treatment opportunities, as judicious use of antimicrobials is important to preventing further resistance. One resource these physicians should be familiar with is the CDC Campaign to Prevent Antimicrobial Resistance that was launched in 2002. It provides evidence-based principles for judicious use of antimicrobials and tools for implementation. These documents can be found at www.cdc.gov/drugresistance/healthcare (Seigel, et al, 2006).

Ninety-four percent of national departments stated they used NFPA standards as the guiding document for their infection control policies and procedures. How often are personnel educated using the document? This question was not specifically asked, but if a physician is involved, it can be posited there will be a higher likelihood of this occurring. An area of education that TFD appears to be able to improve upon is personnel's knowledge of policy and procedures regarding certain levels of PPE when engaging certain types of environments, as only 54% of respondents indicated they knew of this policy. The area of PPE cleaning is another weak spot in that only 67% of personnel knew there was policy for this. The knowledge on the

reporting of exposures appears to be high with 88% stating they knew the policy. However, education on exposure routes may be an area needing attention as 72% stated they would wear eye protection for a patient with an open wound (greatest potential for CA-MRSA spread) (CDC, 2002), while only 44% stated they would wear respiratory tract protection.

During responses, it stands to reason that if less people are in direct contact with either the patient or environment, there will be less exposure. Company Officers should be educated as to when to apply this practice. Although a workplace engineering modification, education in this area should be continued and reminders sent through chain of command as this is counter-intuitive to how firefighters operate at the scene of emergency medical responses. The one comment by the Captain within the open section of the questionnaire was insightful in that removing himself from the environment is a mitigation strategy he already employs. This information should be passed on.

Engineering is the second of the 3 ‘E’s, but it is equally as important. The CDC uses the 5 ‘C’s to guide in the prevention of contamination. These 5 ‘C’s can be used to guide engineering practices not only within the fire station, but also on a personal level.

As stated above, there is room for improvement within the education arena in the area of cleaning and product use. Engineering these products into the firefighter environment is necessary to assist in the mitigation of communicable diseases in general. What products to use is a difficult subject. Understanding the differences between disinfectants and sanitizers is also important. Hard surface cleaning is easier and more effective. There are few (if any) products that can clean the soft surfaces (Reynolds, 2008). One of the areas that were positive for MRSA in the Tucson Study was cloth couches. After finding this, TFD began replacing the cloth with a

leather-like material which allows for cleaning. This product also has an anti-bacterial layer which provides protection against absorption. Carpeting can also harbor germs such as MRSA and cannot be completely cleaned. TFD has also done a good job in that all carpeting has been removed from dorm rooms and replaced with tile, which is easily cleaned. The questionnaire revealed that 22% of national department respondents have similar type furniture covering, with most (67%) having a combination of cloth and vinyl or leather-type material. Floor coverings indicated in the national questionnaire are mainly a combination of carpet and tile (61%), but 28% did indicate tile only.

Hospitals are using ventilation as a means of reducing bacteria (Kane, 2004). It appears TFD is doing well in this area. It is possible that fire departments nationally as well as TFD could improve air quality within the environment to assist in this area of mitigation and prevention. Assuring positive pressure within the station is key (Kane, 2004; Siegel, et al, 2007).

Hand washing is the first line of defense in the reduction in infection communication (CDC, 2002). Siegel, et al, (2006) states there is ample evidence to suggest that multi-drug resistant organisms (MDRO's) are carried from one person to another via the hands of health care providers. This is an area TFD can improve as Table 4 suggests that personnel can either wash hands more often or use the hand gels provided. When asked if hand washing was the number one way to prevent disease spread, TFD respondents agreed with this statement 67% of the time, indicating there is room for improvement here. West (2007) corroborates this when she states that while hand washing is the number one method for protection against infectious disease, studies indicate compliance is low. Forty-six percent of TFD respondents indicated they would use the hand gel dispensers if they were located throughout the station. This appears to be an area

that TFD can engineer more protection into the environment as currently there are no dispensers mounted throughout stations. National respondents (62%) indicated they have signage around the station to assist personnel in remembering to wash hands. TFD personnel indicated (71%) that if signs were put up in stations, they would find this helpful in mitigating infectious disease. This project is in its infancy and will include signs at entry points to stations indicating 'now entering clean zone' and reminders of not just to wash hands, but also actual directions on how to effectively wash hands as well.

Seventy-eighty percent of national respondents indicated they have policies and procedures for dealing with certain patient subsets that present with an increased risk for infectious disease, however only 28% responded they have similar procedures in place for environments that carry the increase in risk. TFD has these policies in place (TFD, 2004) as indicated in Tables 2 and 3. This should remain a topic of continued prompting to the field as there can be a natural tendency to complacency. Another pre-arrival mitigation strategy is assuring responders receive information regarding the potential for increased risk of communicable disease *prior* to arrival on scene. Seventy-two percent of national respondents indicated they have pre-arrival information procedures. This is true also of TFD in that the three questions of cough, fever or known disease are asked and shared.

Seigel, et al, (2006) indicates in two of three studies evaluating gloves with or without gowns for all patient contacts to prevent Vancomycin Resistant Enterococcus (VRE) acquisition in ICU settings, that use of both gloves and gowns reduced VRE transmission. This can be reasonably inferred to the prehospital environment as firefighters respond to patients with these bacteria as well as MRSA, and both fall into the category of MDRO's. All national respondents

indicated they had policies related to certain levels of PPE to be used when engaging certain patient types. This appears to be a weak area of knowledge for TFD as only 54% indicated they knew of policies pertaining to particular call types. Company officer proficiency in this area is a key, allowing for knowledge to transfer from leadership to subordinate. Respiratory protection also appears to be a weak area. This is known to the author as he handles these issues for TFD and he estimates a full 85% of total exposures could be eliminated with the simple wearing of a mask. Only 54% of TFD respondents stated they wear gloves on every call, a number the author would have thought to be much higher, however, 20% more indicated they base glove wearing on patient environment. When asked about mask wearing, 71% of TFD respondents indicated they based it upon patient environment as well. This is of concern as a great deal of personnel do not appear to realize there is policy for guiding when and where to apply certain levels of PPE. Education and enforcement are critical here to raise not only the awareness, but the compliance in this area. Although sleeve and gown protection are less likely to be used, Seigel's study (2006) makes a strong case that this should be undertaken. Although time consuming, cumbersome, and potentially embarrassing for the patient, these can no longer be excuses for non-compliance. This is a matter of basic human interaction skills. As Seigel (2006), indicates in two studies that patients placed on contact precautions for MRSA had increased anxiety, depression, and expressed greater dissatisfaction with their treatment, it will be important that firefighters can treat patients with the care needed emotionally as well.

Once the call is over, there are always decontamination procedures that must be undertaken. If proper PPE and work place engineering have taken place, this is minimized; however, where there is an increased risk due to patient type and/or environment, it will be

important that policies and procedures are in place to give guidance to personnel. Seigel (2006) states the most common reason for environmental contamination was a lack of compliance with agency procedures for cleaning and disinfecting. This lends support for the need to have these policies and procedures engineered into the workplace. Eighty-nine percent of national respondents indicated they had polices/procedures for cleaning of medial equipment, but only 78% for cleaning the apparatus. This is an important topic and West (2007) indicates it is not a new topic in that since the prevalence of HIV and Hepatitis B and C in the 1970's and early 1990's, there has been a strong focus to more thoroughly and completely clean medical equipment. Apparatus are cleaned on a daily basis as a matter of pride in the fire service. Cleaning the inside with appropriate products in the recommended manner can obviously assist with mitigation and cross contamination. Only 21% of TFD respondents indicated their units cleaned the steering wheel of the apparatus daily, 8% the apparatus seats, and 29% the medical equipment. This is an area of concern and should be a point to emphasis for TFD. A more regular cleaning of the apparatus and medical equipment, coupled with the mandate of leaving certain items such as turnouts and medical equipment outside of the living area can greatly reduce the possibility of cross contamination. This is supported by hospital practice of separating clean and dirty areas, and is obviously an area that can be improved upon as only 50% of national departments had policy for separating clean and dirty areas and only 67% of TFD respondents indicated they were aware of the TFD policy regulating this.

The cleaning of PPE is also a vital engineering and mitigation process. All firefighters have a duty or station uniform and some form of turnout gear. Turnout gear consists of NFPA 1971 *Standard on Protective Ensembles for Structural Firefighting and Proximity Firefighting*

(2007) approved materials that retard heat and offer protection not only from fire related issues, but also from cuts, glass, power tools, etc. Turnouts, however, cannot be washed as regularly due to the fact that the material they are made with will break down and not provide adequate thermal protection (NFPA, 2008). Turnouts are also contaminated with the products of combustion and this can then be transferred to the firefighter living environment if they are worn in areas of the station where cross contamination is possible. As De Noon (2008) found, there are areas in society where MRSA can be found, including workout equipment, handles, and common showering areas. It can be reasonably posited that if firefighters wear their turnouts into patient environments, by virtue of not laundering them as regularly as other forms of clothing such as duty uniforms, it can be a vector source for contamination. This, coupled with the study published in the *Journal Watch Emergency Medicine* (2007, April), where 48 percent of ambulances tested positive for MRSA, it is basic that the wearing of an article of clothing that cannot be as regularly decontaminated should be reduced as much as possible. Lejune and Berkowitz (2000) also state that MRSA can live on surfaces for an "undetermined" length of time. Engineering policies and procedures as to when and where turnouts are allowed for use can assist in this area of mitigation.

While 100% of respondents stated they had policy for the cleaning of turnouts, only 62% had policy for cleaning of regular duty uniforms. This compares to 78% having policies for the cleaning of apparatus and 89% for the cleaning of medical equipment. Seventy-five percent of TFD respondents stated they wash their turnouts in the station, while 4% indicated both station and home. Regulating when personnel wear turnouts on non-fire related calls is one way to overcome the potential cross contamination. TFD should work toward a policy pertaining to this.

In the TFD questionnaire, respondents (46%) said they wear their turnouts to medical calls “sometimes”. This is an obvious place for TFD improvement. It is now TFD policy to no longer wear turnouts into the station for any reason, but 8% of personnel indicated they do. Nationally, 57% of respondents indicated they wear turnouts into the station. It is also clear that personnel wear their duty uniform more often to medical calls than turnouts, which leaves them potentially a source of contamination. The duty uniform is the preferable attire for medical calls simply because these can be washed much more frequently and changed as needed. When asked if they cleaned their turnouts via the station or at home, only 39% of national departments had policy for the cleaning of duty uniforms in the station, rather than at home, a potential source of cross contamination to family. This is opposite of the 100% response for policy on washing of turnout gear within the station. TFD does not have current policy for the washing of duty uniforms at the station. Fifty percent of the TFD respondents indicated this policy exists, another indication of education need. TFD personnel (50%) stated turnouts must be cleaned at specific times and under specific circumstances, however, duty uniforms are taken home to clean by 67% of respondents. This is an area TFD can have immediate and solid impact.

How to care for turnouts is a subject covered by manufacturer’s recommendations and NFPA 1851 *Standard on Selection, Care and Maintenance of Protective Ensembles for Structural Firefighting (2008)*, but duty uniforms typically are washed as other clothing. According to Dr. Reynolds, the drying portion of the cleaning process kills more bacteria. In her June 30, 2008 interview, she states that there are studies ongoing as to the effectiveness and setting for dryer temperatures. NFPA 1851 (2008) indicates a temp of at least 105 F. According

to the literature review, LAFD, Mesa, and Phoenix fire departments have all instituted policies and procedures on cleanliness, hygiene and PPE, with much success.

Legislation pertaining to MRSA is an area that can be engineered into the protection of firefighters. This appears to be a topic on the national agenda as several states are putting into motion, legislation on reporting and coverage of communicable disease (MRSA Screening and Reporting Act, 2007); (Mendez, 2008). Although all national department respondents indicated they had policy and procedure mandating the reporting of exposures, only 33% indicated they had legislative action in place to assure personnel were covered presumptively in the event of a MRSA diagnoses. TFD is ahead in this area as Governor Napolitano signed into law on May 24, 2007; a bill that was introduced after the Professional Firefighters of Arizona and Dr. Wayne Peate, MD, MPH brought it to legislators--another major point for having a physician familiar with field issues and NFPA standards (Workers Compensation Infectious Disease Exposure Act, 2007). Although it is law, it is incumbent upon members and administration to continue the timely reporting of exposures and use of the Code 90 to link potential source patients. This will undoubtedly assist with claim pursuance.

The third and final ‘E’ is enforcement. While normally associated with negative connotations, enforcement can come from a variety of sources. Seigel, et al, (2006) says that in one study, hospitals were found to have a decrease in MDRO acquisition when they were monitored for compliance regularly. This is an area company officers can improve upon and it seems through the questionnaires they have support to do so. National respondents indicated they would discipline personnel for infection control policy infractions (57%). TFD respondents (67%) indicate they should be expected to follow infection control policies and practices.

Although 71% of TFD respondents indicated it is the individual's responsibility, sixty-three percent of TFD respondents indicated they would be thankful if a junior member reminded them to put on appropriate PPE and 13% said they would expect them to. This would lead the author to posit that 76% of the department is 'ok' with being held accountable, a number higher than expected. But when asking a junior member if they felt comfortable with reminding the senior member, 20% stated they would never feel as though they could. This indicates a culture shift from the author's perspective that TFD should take advantage of and through education of junior members and company officers, encourage accountability in the area of infection control practices.

Recommendations

Tucson Fire Department should continue to fund an infection control position and give them the educational opportunities to stay abreast of current issues and trends. It is also critical TFD continue to engage in contract with an Industrial Physician, who understands the firefighter/pre-hospital environment and can correctly interpret National Fire Protection Agency (NFPA) standards. Access to specialists in the areas of infection control and diseases is also highly recommended. In the case of the Tucson firefighter (cited earlier), treatment by a world-renowned infectious control specialist from the University of Arizona was critical to his return to full duty.

Follow up studies should be done in conjunction with the University of Arizona College of Public Health to determine if mitigation therapies are working. Safety grants should be applied for as funding sources.

At minimum, annual education should be conducted on infection control policies and practices. This education should be rank specific during certification education as well, to give the company officers the direction and knowledge necessary to be successful in implementing mitigation therapies. This education should be built around the results of this research to assure identified weak areas are corrected and include both commissioned and non-commissioned personnel. Using case histories to educate the firefighting corps will ultimately result in increased compliance as it is made 'real' to them. Pertinent to the educational process, should be the recognition of potential MRSA infections. Personnel should be educated to request testing for MRSA where appropriate and it should be a prime thought should personnel present with end-organ type illnesses.

Policies and procedures for cleaning certain areas of the firefighter environment should be created, personnel educated to them, and then strictly enforced. It is obvious that the problem of MRSA is only one of the many infection control issues facing TFD and a general set of these policies and procedures will surely be of help.

TFD should employ the advice and expertise of infection control experts to assist with choosing products that are effective, time sensitive and easy to use. The goal should be to impact the firefighter the least while providing the protection deserved. This expert should also be consulted regarding vaccines against MRSA and when available, all TFD personnel should receive the inoculation.

A 'clean' and 'dirty' area of stations should be agreed upon and subsequently properly marked not only physically, but with policy so members have clear direction, expectation and accountability for knowing, following, and for supervisory personnel, enforcing the policies

when necessary. Turnout ensembles should not be allowed into the station living, eating or bedroom facilities.

TFD policy should indicate that turnouts not be worn on non-fire based calls unless needed for immediate protection such as on auto extrications. This will ensure that not only will they last longer, but will be reduced as a vector for cross contamination.

Proper care of PPE is also critical as it is obvious that a cleaner uniform or turnout will be less likely to transfer organisms from area to area. TFD needs to analyze the purchasing of washing machines so that there are separate machines for turnouts and duty uniforms. There should also be commercial dryers available in each station. TFD should also make it policy that duty uniforms are washed only at the station and not taken home. This will assist with potential cross contamination issues.

Hand washing signs should be located throughout the station environment, especially in areas such as restrooms and kitchen. Hand sanitizing agents containing a minimum of 62% alcohol are recommended at each entry point into the station living area. There are several styles and types, but automatic are recommended as they offer a more functional and less time-consuming method of disbursement. When the firefighter uses this prior to touching door handles going into station, it will reduce cross contamination. However, compliance in a busy station is also a concern. Company officers should monitor this area for compliance as warranted.

Standard Operating Guidelines should be developed for apparatus and station cleaning. This should be included in education and enforced by station officers to assure the station is not only cleaned, but cleaned properly.

Legislation should be monitored to assure the protection of personnel. Other disease processes that pose a real threat to firefighters should be included in the presumptive law list.

Enforcement strategies for infection control issues should be employed and expectations set of company officers, so there is no doubt where administration stands with regard to these policies. The wearing of proper PPE on medical calls should be a high priority. The TFD discipline matrix should be employed to regulate the infractions in a fair and consistent manner.

TFD as an organization would benefit from these recommendations as they would ensure a safer, healthier, more protected work force. This immediately translates into more productive employees, a reduction in medical costs and more importantly a reduction in the trauma both physically and mentally that can occur as an employee works their way through an issue of potential serious exposure.

The changes recommended above should be driven by the TFD Infection Control Committee. The committee should be used so all stakeholders are represented. Policies should be created and passed up the chain of command by the Infection Control Officer for approval.

Another study should be commissioned after the majority of these recommendations are implemented to see if progress has been made. Similar questioning should be used so data points can be compared.

Other researchers interested in replicating this study should first gain permission from administration, be assured they have proper alliance with those healthcare professionals who can assist, and become familiar with NFPA and CDC standards and recommendations prior to conducting the study.

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